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## ARTICLE XV.

*Observations of the Magnetic Dip in the United States. Fourth Series. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. Read May 6, 1842.*

ALTHOUGH my dipping needle might be regarded as tolerably well tested by the observations in different azimuths, contained in the Society's Transactions, Vol. VIII., p. 66, still, as this examination was limited to a portion of the axis of each needle, I was disposed to institute another trial. For this purpose I resorted to the method of Mayer, loading the needles with sealing-wax. The following tables exhibit a summary of the observations. Columns second and third show the observed angles with a vertical, when a mark on the face of the needle was turned successively to the east and west; columns fourth and fifth show the same with the polarity reversed. The last column shows the dip deduced by Mayer's formula.

NEEDLE No. 1.

DATE.	POLES DIRECT.		POLES REVERSED.		DIP DEDUCED.
	Mark East.	Mark West.	Mark West.	Mark East.	
1841, April 27, 8— 9, A. M.	17° 8'.4	+ 17° 17'.9	17° 22'.3	+ 16° 56'.6	72° 48'.7
May 13, 7— 8, A. M.	39 27.8	— 9 57.9	37 48.9	— 10 12.0	44 .5
May 15, 7—12, A. M.	41 39.5	— 13 22.5	38 11.3	— 10 44.0	42 .7
“ “ “ ” ”	49 6.6	— 26 34.9	45 54.2	— 23 45.8	44 .6
“ “ “ ” ”	51 52.0	— 31 42.0	46 2.7	— 24 1.3	46 .7
“ “ “ ” ”	61 28.3	— 49 19.7	56 1.2	— 42 29.2	53 .2
“ “ “ ” ”	59 32.6	— 45 55.2	56 20.5	— 42 57.1	51 .9
“ “ 1— 6, P. M.	60 23.9	— 47 25.5	57 39.2	— 45 22.8	52 .6
“ “ “ ” ”	34 10.6	— 1 49.4	39 25.1	— 13 17.8	42 .8
“ “ “ ” ”	27 20.2	+ 6 41.8	27 25.1	+ 5 11.6	42 .7
“ “ “ ” ”	24 44.4	+ 10 18.5	23 30.6	+ 9 11.2	47 .4
“ “ “ ” ”	17 11.1	+ 17 22.6	16 52.4	+ 17 23.3	47 .6
Mean of 12 observations, Needle No. 1, (960 readings,) . . . . .					72° 47.1

## NEEDLE No. 2.

DATE.	POLES DIRECT.		POLES REVERSED.		DIP DEDUCED.
	Mark East.	Mark West.	Mark West.	Mark East.	
1841, May 18, 7—12, A. M.	56° 34'.5	— 42° 49'.9	63° 9'.2	— 52° 36'.0	72° 43'.4
" " "	57 31 .7	— 44 52 .4	61 30 .6	— 49 22 .8	43 .1
" " "	53 47 .2	— 38 20 .6	55 56 .2	— 39 17 .3	52 .2
" " "	47 43 .2	— 27 55 .8	53 58 .5	— 34 49 .1	49 .6
" " "	43 9 .5	— 19 43 .4	44 12 .6	— 17 29 .4	48 .8
" " "	40 8 .1	— 14 24 .2	39 55 .2	— 10 19 .0	43 .8
" " "	36 24 .2	— 8 33 .2	34 57 .2	— 3 13 .8	51 .3
" " 1— 4, P. M.	31 3 .1	— 0 54 .1	30 2 .3	+ 3 32 .3	53 .4
" " "	25 52 .7	+ 6 20 .6	25 2 .0	+ 9 41 .9	47 .3
" " "	22 43 .0	+ 10 35 .2	21 3 .3	+ 13 23 .3	52 .5
" " "	15 36 .3	+ 18 48 .3	15 55 .2	+ 18 35 .8	46 .1

Mean of 11 observations, Needle No. 2, (880 readings,) . . . . 72° 48'.3

The discordances between the individual results are somewhat greater than had been expected, nevertheless the average agrees very closely with the dip formerly obtained. This method of observing has the advantage of testing successively every part of the axis of the needle, yet, otherwise, it is much inferior to the common method, for the load serves to increase the friction of the axis, and the same error in the observations produces greater influence on the results. In order to determine what correction should be applied to observations made in the usual method, we need first to know the annual change of dip. For this purpose I have compared observations made at this place since 1838. The following table exhibits the materials for comparison. In the equations of condition,  $\delta$  represents the mean dip for January 1, 1838, and  $\Delta$  the annual change of dip.

OBSERVATIONS.	EQUATIONS OF CONDITION.	DIFFERENCES.
1838, Sept. 8, 72° 48'.2	$\delta + .684 \Delta = 8'.2$	+ 0'.1
1839, April 22, 46 .8	$\delta + 1.304 \Delta = 6 .8$	— 1 .4
Aug. 17, 48 .4	$\delta + 1.624 \Delta = 8 .4$	+ 0 .2
1840, Jan. 11, 49 .5	$\delta + 2.027 \Delta = 9 .5$	+ 1 .2
Aug. 31, 49 .5	$\delta + 2.665 \Delta = 9 .5$	+ 1 .1
1841, May 10, 47 .4	$\delta + 3.353 \Delta = 7 .4$	— 1 .2
Nov. 4, 48 .7	$\delta + 3.841 \Delta = 8 .7$	0 .0

These equations, being solved by the method of minimum squares, give  $\delta = 7'.95$ , or the mean dip, January 1, 1838,  $72^\circ 47'.95$ ,  $\Delta = + 0'.18$ , from

which we obtain the differences between the observed and computed dips, as given in the last column above. The dip obtained August, 1840, by observations in different azimuths, was  $72^{\circ} 49'.6$ , being  $1'.2$  greater than is computed from the above data; the dip, May, 1841, by Mayer's method, was  $72^{\circ} 47'.7$ , being  $0'.9$  less than we obtain from the same data. Mean error of observations by the usual method  $+ 0'.1$ , a quantity so small that it has been neglected.

The following observations were made by the usual method.

*Magnetic Dip at Brooklyn, Ohio. Latitude  $41^{\circ} 30' N.$ ; Longitude  $81^{\circ} 43' W.$*

Place of observation one mile west of Ohio city.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, April 23,	11—1, P. M.	No. 1,	40	$73^{\circ} 10'.2$
"	"	No. 1, poles reversed,	40	18.9
"	"	Mean of No. 1,	80	14.6
"	"	No. 2,	40	19.7
"	"	No. 2, poles reversed,	40	16.3
"	"	Mean of No. 2,	80	18.0
"	"	Mean of both needles,	160	$73^{\circ} 16'.3$

*Magnetic Dip at Tallmadge, Ohio. Latitude  $41^{\circ} 6' N.$ ; Longitude  $81^{\circ} 27' W.$*

Place of observation nearly the same as formerly.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, April 26,	8—10, A. M.	No. 1,	40	$72^{\circ} 55'.6$
"	"	No. 1, poles reversed,	40	49.1
"	"	Mean of No. 1,	80	52.4
"	"	No. 2,	40	52.4
"	"	No. 2, poles reversed,	40	63.5
"	"	Mean of No. 2,	80	58.0
"	"	Mean of both needles,	160	$72^{\circ} 55'.2$

*Magnetic Dip at Cleveland, Ohio. Latitude  $41^{\circ} 30' N.$ ; Longitude  $81^{\circ} 41' W.$*

Place of observation one mile east of the city.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 12,	4—1, P. M.	No. 1,	40	$73^{\circ} 7'.9$
"	"	No. 1, poles reversed,	40	2.0
"	"	Mean of No. 1,	80	5.0

## OBSERVATIONS OF THE

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 12,	4—1, P. M.	No. 2,	40	73° 3 .4
"	"	No. 2, poles reversed,	40	3 .9
"	"	Mean of No. 2,	80	3 .7
"	"	Mean of both needles,	160	73 4' .3

I have now made four observations for the dip near Cleveland. First, upon the north side of the city; then upon the south side; next upon the west; and, last, upon the east. The dip at Cleveland, according to observations made in the neighbouring towns, should be 73° 4'.0. The station error, then, of the first observation was + 22'.0; of the second, + 8'.0; third, + 12'.3; fourth, + 0'.3. Corresponding anomalies have been detected in observations for the variation of the needle in this vicinity.

*Magnetic Dip at Monroe, Michigan. Latitude 41° 55' N., Longitude 83° 28' W.*

Place of observation a half mile north of the court house.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 14,	2—4, P. M.	No. 1,	40	73° 15'.9
"	"	No. 1, poles reversed,	40	22 .7
"	"	Mean of No. 1,	80	19 .3
"	"	No. 2,	40	19 .2
"	"	No. 2, poles reversed,	40	18 .4
"	"	Mean of No. 2,	80	18 .8
"	"	Mean of both needles,	160	73 19 .0

*Magnetic Dip at Ypsilanti, Michigan. Latitude 42° 14' N.; Longitude 83° 38' W.*

Place of observation sixty rods east of the rail-road dépôt.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 16,	7—9, A. M.	No. 1,	40	73° 24'.1
"	"	No. 1, poles reversed,	40	15 .5
"	"	Mean of No. 1,	80	19 .8
"	"	No. 2,	40	17 .4
"	"	No. 2, poles reversed,	40	18 .1
"	"	Mean of No. 2,	80	17 .8
"	"	Mean of both needles,	160	73 18 .8

*Magnetic Dip at Ann Arbor, Michigan. Latitude 42° 18' N.; Longitude 83° 45' W.*

Place of observation twenty rods south of the rail-road dépôt.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 16,	11—1, P. M.	No. 1,	40	73° 14'.3
"	"	No. 1, poles reversed,	40	19 .3
"	"	Mean of No. 1,	80	16 .8
"	"	No. 2,	40	17 .4
"	"	No. 2, poles reversed,	40	15 .0
"	"	Mean of No. 2,	80	16 .2
"	"	Mean of both needles,	160	73 16 .5

As the results obtained in 1839, at the last three stations, seemed quite anomalous, I was desirous of verifying them. The stations of observation were purposely taken at some distance from the former ones, to avoid any local influence of limited extent. The results at Ann Arbor and Ypsilanti are almost identically the same as before; at Monroe the last result accords much better with what might be expected from the general course of the isoclinal lines. Some indications of disturbing influences are apparent in the geological character of this section. Throughout most of it is found a deposite of blue clay, containing nearly two per cent. of iron. Iron ore is also quite common.

*Magnetic Dip at Detroit, Michigan. Latitude 42° 19' N.; Longitude 83° 3' W.*

Place of observation one mile west of the city.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 17,	8—10½, A. M.	No. 1,	40	73° 40'.9
"	"	No. 1, poles reversed,	40	30 .0
"	"	Mean of No. 1,	80	35 .5
"	"	No. 2,	40	34 .4
"	"	No. 2, poles reversed,	40	38 .5
"	"	Mean of No. 2,	80	36 .5
"	"	Mean of both needles,	160	73 36 .0

*Observations repeated ten Rods North of former Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 17	10½—12½, A. M.	No. 1,	40	73° 30'.8
"	"	No. 1, poles reversed,	40	39 .0
"	"	Mean of No. 1,	80	34 .9

## OBSERVATIONS OF THE

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 17,	10½—12½, A. M.	No. 2,	40	73° 38'.0
"	"	No. 2, poles reversed,	40	33 .4
"	"	Mean of No. 2,	80	35 .7
"	"	Mean of both needles,	160	73 35 .3

*Observations repeated three Rods West of last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 17,	3—5, P. M.	No. 1,	40	73° 35'.3
"	"	No. 1, poles reversed,	40	30 .1
"	"	Mean of No. 1,	80	32 .7
"	"	No. 2,	40	32 .1
"	"	No. 2, poles reversed,	40	38 .7
"	"	Mean of No. 2,	80	35 .4
"	"	Mean of both needles,	160	73 34 .1

*Observations repeated near the second Locality.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 18,	8½—10, A. M.	No. 1,	40	73° 30'.2
"	"	No. 1, poles reversed,	40	38 .5
"	"	Mean of No. 1,	80	34 .4
"	"	No. 2,	40	40 .6
"	"	No. 2, poles reversed,	40	34 .8
"	"	Mean of No. 2,	80	37 .7
"	"	Mean of both needles,	160	73 36 .0

*Observations repeated on the same Spot.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 18,	10—12, A. M.	No. 1,	40	73° 39'.9
"	"	No. 1, poles reversed,	40	29 .6
"	"	Mean of No. 1,	80	34 .8
"	"	No. 2,	40	34 .4
"	"	No. 2, poles reversed,	40	41 .2
"	"	Mean of No. 2,	80	37 .8
"	"	Mean of both needles,	160	73 36 .3

Mean of 800 readings at Detroit, with both needles, . . . . . 73 35 .5

The close agreement of the results in the five preceding series of observations shows that very little is gained, in point of accuracy, by multiplying the observations beyond the usual number of a single series.

*Magnetic Dip at Mackinac, Michigan. Latitude 45° 51' N.; Longitude 84° 41' W.*

Place of observation a quarter of a mile south-west of the fort.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 21,	8—10, A. M.	No. 1,	40	76° 33'.4
"	"	No. 1, poles reversed,	40	42 .2
"	"	Mean of No. 1,	80	37 .8
"	"	No. 2,	40	43 .4
"	"	No. 2, poles reversed,	40	35 .2
"	"	Mean of No. 2,	80	39 .3
"	"	Mean of both needles,	160	76 38 .5

*Observations repeated on the same Spot.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 21,	10—12, A. M.	No. 1,	40	76° 43'.0
"	"	No. 1, poles reversed,	40	37 .6
"	"	Mean of No. 1,	80	40 .3
"	"	No. 2,	40	34 .6
"	"	No. 2, poles reversed,	40	40 .5
"	"	Mean of No. 2,	80	37 .5
"	"	Mean of both needles,	160	76 38 .9

*Observations repeated fifteen Rods North-East of last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 21,	2—3½, P. M.	No. 1,	40	76° 36'.3
"	"	No. 1, poles reversed,	40	41 .5
"	"	Mean of No. 1,	80	38 .9
"	"	No. 2,	40	38 .7
"	"	No. 2, poles reversed,	40	32 ,0
"	"	Mean of No. 2,	80	35 .4
"	"	Mean of both needles,	160	76 37 .1

*Observations repeated on the same Spot.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 21,	3½—5, P. M.	No. 1,	40	76° 39'.4
"	"	No. 1, poles reversed,	40	31 .4
"	"	Mean of No. 1,	80	35 .4
"	"	No. 2,	40	33 .3
"	"	No. 2, poles reversed,	40	38 .4
"	"	Mean of No. 2,	80	76 35 .8
"	"	Mean of both needles,	160	76 35 .6

Mean of 640 readings at Mackinac, with both needles, . . . . . 76 37 .5

The same conclusion might be derived from these observations as from those at Detroit, with regard to the inutility of multiplying beyond a certain point the observations at one place. If the observations are to be repeated, the object being to obtain the mean dip of the place, it seems better to change the locality, if it be only by a few rods, by which means any disturbing causes of limited extent will probably be detected.

*Magnetic Dip at Fort Brady, Michigan. Latitude 46° 30' N.; Longitude 84° 24' W.*

Place of observation fifty rods south-east of the south-east angle of the fort.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 25,	2—5, P. M.	No. 1,	40	77° 25'.3
"	"	No. 1, poles reversed,	40	33 .1
"	"	Mean of No. 1,	80	29 .2
"	"	No. 2,	40	28 .5
"	"	No. 2, poles reversed,	40	25 .4
"	"	Mean of No. 2,	80	27 .0
"	"	Mean of both needles,	160	77 28 .1

*Observations repeated eighteen Rods South-West of the last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 25,	5—7, P. M.	No. 1,	40	77° 33'.0
"	"	No. 1, poles reversed,	40	25 .4
"	"	Mean of No. 1,	80	29 .2
"	"	No. 2,	40	25 .5
"	"	No. 2, poles reversed,	40	27 .2
"	"	Mean of No. 2,	80	26 .4
"	"	Mean of both needles,	160	77 27 .8

*Observations repeated near the River, at the foot of the Rapids.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 27,	5—7, A. M.	No. 1,	40	77° 36'.9
"	"	No. 1, poles reversed,	40	30 .3
"	"	Mean of No. 1,	80	33 .6
"	"	No. 2,	40	29 .5
"	"	No. 2, poles reversed,	40	36 .2
"	"	Mean of No. 2,	80	32 .9
"	"	Mean of both needles,	160	77 33 .2
<i>Mean of 480 readings with both needles,</i>		.	.	77 29 .7

*Magnetic Dip at Gros Cap, Canada. Latitude 46° 32' N.; Longitude 84° 43' W.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 26,	1—3, P. M.	No. 1,	40	77° 4'.8
"	"	No. 1, poles reversed,	40	8 .9
"	"	Mean of No. 1,	80	6 .9
"	"	No. 2,	40	6 .9
"	"	No. 2, poles reversed,	40	0 .4
"	"	Mean of No. 2,	80	3 .6
"	"	Mean of both needles,	160	77 5 .3

The difference in the dip observed at Gros Cap, and at Fort Brady, is 24'.4, whereas the dip at the two places might have been anticipated to be nearly the same. At the Sault the red sandstone appears on the surface of the earth, and contains a large per centage of iron.

*Magnetic Dip at South Manitou, Michigan. Latitude 45° 5' N.; Longitude 85° 38' W.*

Place of observation near the eastern shore, about the middle of the island, as regards north and south.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Aug. 31,	9—10½, A. M.	No. 1,	40	75° 55'.4
"	"	No. 1, poles reversed,	40	62 .6
"	"	Mean of No. 1,	80	59 .0
"	"	No. 2,	40	67 .5
"	"	No. 2, poles reversed,	40	51 .9
"	"	Mean of No. 2,	80	59 .7
"	"	Mean of both needles,	160	75 59 .3

*Magnetic Dip at Chicago, Illinois. Latitude 41° 53' N.; Longitude 87° 44' W.*

Place of observation one mile north of the town.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 2,	8½—10½, A. M.	No. 1,	40	72° 50'.6
"	"	No. 1, poles reversed,	40	47 .0
"	"	Mean of No. 1,	80	48 .8
"	"	No. 2,	40	47 .8
"	"	No. 2, poles reversed,	40	46 .5
"	"	Mean of No. 2,	80	47 .1
"	"	Mean of both needles,	160	72 48 .0

*Observations repeated five Rods West of last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 2,	10½—12½, A. M.	No. 1,	40	72° 47' .6
"	"	No. 1, poles reversed,	40	50 .2
"	"	Mean of No. 1,	80	48 .9
"	"	No. 2,	40	45 .9
"	"	No. 2, poles reversed,	40	46 .3
"	"	Mean of No. 2,	80	46 .1
"	"	Mean of both needles,	160	72 47 .5
Mean of 320 readings with both needles,		" . . . . .	" . . . . .	72 47 .7

*Magnetic Dip at Galena, Illinois. Latitude 42° 28' N.; Longitude 90° 13' W.*

Place of observation on the hill back of the town.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 4,	8—10, A. M.	No. 1,	40	72° 64'.4
"	"	No. 1, poles reversed,	40	59 .1
"	"	Mean of No. 1,	80	61 .8
"	"	No. 2,	40	61 .4
"	"	No. 2, poles reversed,	40	61 .7
"	"	Mean of No. 2,	80	61 .6
"	"	Mean of both needles,	160	73 1 .7

*Observations repeated four Rods East of last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 4,	10—12, M.	No. 1,	40	73° 1'.3
"	"	No. 1, poles reversed,	40	5 .6
"	"	Mean of No. 1,	80	3 .5
"	"	No. 2,	40	2 .5
"	"	No. 2, poles reversed,	40	0 .7
"	"	Mean of No. 2,	80	1 .6
"	"	Mean of both needles,	160	73 2 .5

*Magnetic Dip at Mineral Point, Wisconsin. Latitude 42° 51' N.; Longitude 89° 58' W.*

Place of observation eighty rods west of the Franklin House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 6,	5—6½, P. M.	No. 1,	40	73° 26'.0
"	"	No. 1, poles reversed,	40	20 .2
"	"	Mean of No. 1,	80	23 .1

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 6,	5—6½, P. M.	No. 2,	40	73° 21'.8
"	"	No. 2, poles reversed,	40	25 .1
"	"	Mean of No. 2,	80	23 .4
"	"	Mean of both needles,	160	73 23 .2

*Magnetic Dip at Blue Mounds, Wisconsin. Latitude 43° 0' N.; Longitude 89° 36' W.*

Place of observation near Mr. Ebenezer Brigham's.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 7,	12—2, P. M.	No. 1,	40	73° 30'.6
"	"	No. 1, poles reversed,	40	40 .7
"	"	Mean of No. 1,	80	35 .6
"	"	No. 2,	40	19 .9
"	"	No. 2, poles reversed,	40	48 .3
"	"	Mean of No. 2,	80	34 .1
"	"	Mean of both needles,	160	73 34 .9

In fording a creek, this morning, near Mineral Point, the compass got wet. It was carefully dried as soon after as possible, and is thought to have experienced no serious injury. This is probably the cause of the inequality in the weight of the arms of No. 2, as shown in the last observation. Nevertheless, the mean results of the two needles accord as well as usual.

*Magnetic Dip at Madison, Wisconsin. Latitude 43° 3' N.; Longitude 89° 11' W.*

Place of observation eighty rods south-east of the capital.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 8,	10—12, A. M.	No. 1,	40	73° 67'.6
"	"	No. 1, poles reversed,	40	59 .0
"	"	Mean of No. 1,	80	63 .3
"	"	No. 2,	40	77 .8
"	"	No. 2, poles reversed,	40	54 .2
"	"	Mean of No. 2,	80	66 .0
"	"	Mean of both needles,	160	74 4 .7

*Observations repeated near the same Place.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 8,	1—3, P. M.	No. 1,	40	73° 62'.6
"	"	No. 1, poles reversed,	40	73 .3
"	"	Mean of No. 1,	80	68 .0
"	"	No. 2,	40	57 .1

## OBSERVATIONS OF THE

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 8,	1—3, P. M.	No. 2, poles reversed,	40	73° 80'.0
"	"	Mean of No. 2,	80	68 .6
"	"	Mean of both needles,	160	74 8 .3
Mean of 320 readings of both needles, . . . . .				74 6 .5

*Magnetic Dip at Campbell's, Wisconsin. Latitude 43° 1' N.; Longitude 89° 26' W.*

Fifteen miles from Madison; ten miles from Blue Mounds.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 9,	5—7, A. M.	No. 1,	40	73° 31'.8
"	"	No. 1, poles reversed,	40	25 .0
"	"	Mean of No. 1,	80	28 .4
"	"	No. 2,	40	42 .3
"	"	No. 2, poles reversed,	40	13 .3
"	"	Mean of No. 2,	80	27 .8
"	"	Mean of both needles,	160	73 28 .1

Between this place and Madison, distant only fifteen miles, and near the same parallel, the difference of dip is 38'.4, whereas they might have been anticipated to have nearly the same dip. There seems to be powerful local attraction near Madison. Iron ore has been found on the lake shore, close to the village, and the surveyor who laid out the town complained that the direction of his compass needle was exceedingly irregular.

*Magnetic Dip at Hickok's, Wisconsin. Latitude 42° 58' N.; Longitude 89° 47' W.*

Ten miles from Blue Mounds; nine miles from Dodgeville.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 9,	11—1, P. M.	No. 1,	40	73° 35'.0
"	"	No. 1, poles reversed,	40	45 .7
"	"	Mean of No. 1,	80	40 .4
"	"	No. 2,	40	26 .2
"	"	No. 2, poles reversed,	40	51 .2
"	"	Mean of No. 2,	80	38 .7
"	"	Mean of both needles,	160	73 39 .5

*Magnetic Dip at Mineral Point, Wisconsin. Latitude 42° 51' N.; Longitude 89° 58' W.*

Place of observation a few rods back of Franklin House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 10,	10—12, A. M.	No. 1,	40	73° 27'.8
"	"	No. 1, poles reversed,	40	21 .9

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 10,	10—12, A. M.	Mean of No. 1,	80	73° 24'.9
"	"	No. 2,	40	33 .9
"	"	No. 2, poles reversed,	40	7 .1
"	"	Mean of No. 2,	80	20 .5
"	"	Mean of both needles,	160	73 22 .7
Mean of 320 readings of both needles, Sept. 9, and 10, -				73 23 .0

*Magnetic Dip at Platteville, Wisconsin. Latitude 42° 43' N.; Longitude 90° 14' W.*

Place of observation a few rods south of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 11,	7—9, A. M.	No. 1,	40	73° 16'.1
"	"	No. 1, poles reversed,	40	21 .9
"	"	Mean of No. 1,	80	19 .0
"	"	No. 2,	40	0 .5
"	"	No. 2, poles reversed,	40	29 .9
"	"	Mean of No. 2,	80	15 .2
"	"	Mean of both needles,	160	73 17 .1

*Observations repeated six rods south of the last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 11,	9—11, A. M.	No. 1,	40	73° 22'.0
"	"	No. 1, poles reversed,	40	15 .1
"	"	Mean of No. 1,	80	18 .5
"	"	No. 2,	40	28 .8
"	"	No. 2, poles reversed,	40	4 .5
"	"	Mean of No. 2,	80	16 .7
"	"	Mean of both needles,	160	73 17 .6
Mean of 320 readings with both needles,				73 17 .4

*Magnetic Dip at Galena, Illinois. Latitude 42° 28' N.; Longitude 90° 13' W.*

Place of observation nearly the same as formerly.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 13,	2—5, P. M.	No. 1,	40	72° 61'.9
"	"	No. 1, poles reversed,	40	70 .5
"	"	Mean of No. 1,	80	66 .2
"	"	No. 2,	40	49 .4
"	"	No. 2, poles reversed,	40	77 .2
"	"	Mean of No. 2,	80	63 .3
"	"	Mean of both needles,	160	73 4 .8
Mean of 480 readings of both needles,				73 3 .0

## OBSERVATIONS OF THE

*Magnetic Dip at Peru, Illinois. Latitude 41° 23' N.; Longitude 89° 5' W.*

Place of observation near the landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 16,	1—3, P. M.	No. 1,	40	71° 55'.9
"	"	No. 1, poles reversed,	40	47 .1
"	"	Mean of No. 1,	80	51 .5
"	"	No. 2,	40	67 .4
"	"	No. 2, poles reversed,	40	39 .3
"	"	Mean of No. 2,	80	53 .3
"	"	Mean of both needles,	160	71 52 .4

*Observations repeated on the hill back of the Landing.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 16,	3—5, P. M.	No. 1,	40	71° 41'.3
"	"	No. 1, poles reversed,	40	52 .7
"	"	Mean of No. 1,	80	47 .0
"	"	No. 2,	40	38 .6
"	"	No. 2, poles reversed,	40	66 .3
"	"	Mean of No. 2,	80	52 .5
"	"	Mean of both needles,	160	71 49 .8
Mean of 320 readings with both needles,	.	.	.	71 51 .1

*Magnetic Dip at Pekin, Illinois. Latitude 40° 35' N.; Longitude 89° 36' W.*

Place of observation a few rods below the steamboat landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 18,	9—11, A. M.	No. 1,	40	71° 12'.9
"	"	No. 1, poles reversed,	40	9 .3
"	"	Mean of No. 1,	80	11 .1
"	"	No. 2,	40	29 .9
"	"	No. 2, poles reversed,	40	0 .8
"	"	Mean of No. 2,	80	15 .3
"	"	Mean of both needles,	160	71 13 .2

*Magnetic Dip at mouth of Copperas Creek, Illinois. Latitude 40° 30' N.; Longitude 89° 48' W.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 18,	2—3, P. M.	No. 1,	40	70° 56'.4

The observations were here interrupted, but from a comparison of preceding and following observations at Pekin and Alton, the dip at Copperas Creek may be inferred to be 71° 4'.0.

September 21.—One end of No. 2 was rubbed on a hone, to reduce the inequality in the weight of the arms.

*Magnetic Dip at Alton, Illinois. Latitude 38° 54' N.; Longitude 90° 4' W.*

Place of observation in Middletown, a half mile from the landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 22,	8—10, A. M.	No. 1,	40	69° 24'.2
"	"	No. 1, poles reversed,	40	36.3
"	"	Mean of No. 1,	80	30.2
"	"	No. 2,	40	37.3
"	"	No. 2, poles reversed,	40	43.6
"	"	Mean of No. 2,	80	40.4
"	"	Mean of both needles,	160	69 35.3

*Observations repeated six Rods East of the last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 22,	10—12, M.	No. 1,	40	69° 36'.4
"	"	No. 1, poles reversed,	40	23.0
"	"	Mean of No. 1,	80	29.7
"	"	No. 2,	40	40.2
"	"	No. 2, poles reversed,	40	37.8
"	"	Mean of No. 2,	80	39.0
"	"	Mean of both needles,	160	69 34.3
Mean of 320 readings of both needles, . . . . .	.	.	.	69 34.8

*Magnetic Dip at Upper Alton, Illinois. Latitude 38° 55' N.; Longitude 90° 3' W.*

Place of observation a few rods east of the college.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 22,	2—4, P. M.	No. 1,	40	69° 34'.0
"	"	No. 1, poles reversed,	40	46.5
"	"	Mean of No. 1,	80	40.3
"	"	No. 2,	40	49.2
"	"	No. 2, poles reversed,	40	50.0
"	"	Mean of No. 2,	80	49.6
"	"	Mean of both needles,	160	69 44.9

*Observations repeated a few rods south of former station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 25,	2—4, P. M.	No. 1,	40	69° 39.8
"	"	No. 1, poles reversed,	40	50.8

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 25,	2—4, P. M.	Mean of No. 1,	80	69° 45'.3
"	"	No. 2,	40	59 .1
"	"	No. 2, poles reversed,	40	35 .9
"	"	Mean of No. 2,	80	47 .5
"	"	Mean of both needles,	160	69 46 .4
Mean of 320 readings of both needles, .		. . . . .	. . . . .	69 45 .7

*Magnetic Dip at Edwardsville, Illinois. Latitude 38° 50' N.; Longitude 89° 53' W.*

Place of observation a few rods west from the court house.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 23,	10—12, M.	No. 1,	40	69° 57'.6
"	"	No. 1, poles reversed,	40	46 .4
"	"	Mean of No. 1,	80	52 .0
"	"	No. 2,	40	63 .9
"	"	No. 2, poles reversed,	40	62 .9
"	"	Mean of No. 2,	80	63 .4
"	"	Mean of both needles,	160	69 57 .7

*Magnetic Dip at Bunker Hill, Illinois. Latitude 39° 4' N.; Longitude 89° 53' W.*

Place of observation one mile north of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 24,	12—2, P. M.	No. 1,	40	69° 37'.9
"	"	No. 1, poles reversed,	40	49 .0
"	"	Mean of No. 1,	80	43 .4
"	"	No. 2,	40	53 .5
"	"	No. 2, poles reversed,	40	56 .1
"	"	Mean of No. 2,	80	54 .8
"	"	Mean of both needles,	160	69 49 .1

*Magnetic Dip at Monticello, Illinois. Latitude 38° 57' N.; Longitude 90° 5' W.*

Place of observation near the Female Seminary.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 25,	9—11, A. M.	No. 1,	40	69° 50'.2
"	"	No. 1, poles reversed,	40	34 .8
"	"	Mean of No. 1,	80	42 .5
"	"	No. 2,	40	20 .4
"	"	No. 2, poles reversed,	40	50 .1
"	"	Mean of No. 2,	80	35 .2
"	"	Mean of both needles,	160	69 38 .9

*Magnetic Dip at St. Louis, Missouri. Latitude 38° 38' N.; Longitude 90° 4' W.*

Place of observation one mile west of the city.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Sept. 29,	9—11, A. M.	No. 1,	40	69° 31'.5
"	"	No. 1, poles reversed,	40	20 .8
"	"	Mean of No. 1,	80	26 .1
"	"	No. 2,	40	16 .5
"	"	No. 2, poles reversed,	40	33 .2
"	"	Mean of No. 2,	80	24 .9
"	"	Mean of both needles,	160	69 25 .5

*Magnetic Dip at Vincennes, Indiana. Latitude 38° 43' N.; Longitude 87° 29' W.*

Place of observation a half mile above the lower ferry, near the bank of the river.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 1,	10—12, M.	No. 1,	40	69° 45'.9
"	"	No. 1, poles reversed,	40	55 .0
"	"	Mean of No. 1,	80	50 .4
"	"	No. 2,	40	63 .1
"	"	No. 2, poles reversed,	40	43 .4
"	"	Mean of No. 2,	80	53 .3
"	"	Mean of both needles,	160	69 51 .9

*Observations repeated three rods north-east of the last Station.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 1,	1—3, P. M.	No. 1,	40	69° 55'.6
"	"	No. 1, poles reversed,	40	47 .1
"	"	Mean of No. 1,	80	51 .3
"	"	No. 2,	40	43 .7
"	"	No. 2, poles reversed,	40	68 .5
"	"	Mean of No. 2,	80	56 .1
"	"	Mean of both needles,	160	69 53 .7
Mean of 320 readings of both needles, .	. . . . .	. . . . .	. . . . .	69 52 .8

*Magnetic Dip at Cincinnati, Ohio. Latitude 39° 6' N.; Longitude 84° 27' W.*

Place of observation, Mr. Longworth's garden, on the east side of the city.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 5,	10—12, M.	No. 1,	40	70° 19'.2
"	"	No. 1, poles reversed,	40	35 .9
"	"	Mean of No. 1,	80	27 .5

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 5,	3—5, P. M.	No. 1,	40	70° 35'.7
"	"	No. 1, poles reversed,	40	20 .0
"	"	Mean of No. 1,	80	27 .8
Mean of both sets of observations,	.	.	160	70 27 .7

I have always taken the greatest pains to preserve my compass and needles free from injury; nevertheless, in travelling a great distance by public conveyances, especially in a new country, some exposure seems unavoidable. The mean results with the two needles agreed very well down to September 22d, at Alton, since which time the results with No. 2 have been quite anomalous. At Edwardsville and Bunker Hill the dip by No. 2 was 11'.4 greater than with No. 1, and at Monticello 7'.3 less. At Cincinnati the difference was still greater, so that from this time I discarded No. 2 altogether. These anomalies I ascribe to rust upon the axis. It was not great, but distinctly visible by a magnifier. I have alluded to such an imperfection in my former paper, p. 67. This rust had doubtless increased during the exposure of the present journey. I have detected no such imperfection in No. 1, and perhaps its indications alone, since September 22d, would be more trustworthy than when united with those of No. 2.

*Magnetic Dip at Columbus, Ohio. Latitude 39° 57' N.; Longitude 83° 3' W.*

Place of observation ninety rods east of the new State House yard.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 7,	2—3, P. M.	No. 1,	40	70° 57'.4
"	"	No. 1, poles reversed,	40	70 .5
"	"	Mean of No. 1,	80	71 4 .0

*Observations repeated ten rods farther east.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 7,	3—4, P. M.	No. 1,	40	70° 69'.7
"	"	No. 1, poles reversed,	40	57 .1
"	"	Mean of No. 1,	80	63 .4
Mean of both sets of observations,	.	.	160	71 3 .7

*Magnetic Dip at Hebron, Ohio. Latitude 39° 59' N.; Longitude 82° 29' W.*

Place of observation a hundred rods north of the stage house.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 8,	1—2, P. M.	No. 1,	40	71° 8'.2
"	"	No. 1, poles reversed,	40	11 .3
"	"	Mean of No. 1,	80	9 .8

*Observations repeated ten rods farther north.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 8,	2—3, P. M.	No. 1,	40	71° 14'.4
"	"	No. 1, poles reversed,	40	6 .4
"	"	Mean of No. 1,	80	10 .4
Mean of both sets of observations,	.	.	160	71 10.1

At the last two stations the dip is materially less than might have been anticipated; nevertheless, I consider the observations entitled to as much confidence as the others.

*Magnetic Dip at Frasersburgh, Ohio. Latitude 40° 9' N.; Longitude 82° 8' W.*

Place of observation near canal lock No. 16.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 9,	10—11, A. M.	No. 1,	40	71° 44'.1
"	"	No. 1, poles reversed,	40	50 .2
"	"	Mean of No. 1,	80	47 .1

*Observations repeated near Canal Lock No. 17.*

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 9,	4½—5½, P. M.	No. 1,	40	71° 54'.3
"	"	No. 1, poles reversed,	40	46 .2
"	"	Mean of No. 1,	80	50 .3
Mean of both sets of observations,	.	.	160	71 48.7

*Magnetic Dip at Dover, Ohio. Latitude 40° 33' N.; Longitude 81° 30' W.*

Place of observation near canal lock, two miles north of the town.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 11,	9—10, A. M.	No. 1,	40	72° 20'.9
"	"	No. 1, poles reversed,	40	18 .7
"	"	Mean of No. 1,	80	19 .8
"	10—11, A. M.	No. 1,	40	16 .0
"	"	No. 1, poles reversed,	40	21 .3
"	"	Mean of No. 1,	80	18 .7
Mean of both sets of observations,	.	.	160	72 19.2

*Magnetic Dip at Fulton, Ohio. Latitude 40° 55' N.; Longitude 81° 38' W.*

Place of observation near the canal lock.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 12,	9—10, A. M.	No. 1,	40	72° 40'.4
"	"	No. 1, poles reversed,	40	37 .4
"	"	Mean of No. 1,	80	72 38.9

*Magnetic Dip at Clinton, Ohio. Latitude 40° 58' N.; Longitude 81° 40' W.*

Place of observation near the canal lock.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 12,	1—2, P. M.	No. 1,	40	72° 43'.2
"	"	No. 1, poles reversed,	40	44 .7
"	"	Mean of No. 1,	80	72 44 .0

*Magnetic Dip at Tallmadge, Ohio. Latitude 41° 6' N.; Longitude 81° 27' W.*

Place of observation twenty rods north of station April 26, 1841.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 13,	11—12, M.	No. 1,	40	72° 52'.2
"	"	No. 1, poles reversed,	40	50 .8
"	"	Mean of No. 1,	80	72 51 .5

*Magnetic Dip at Hudson, Ohio. Latitude 41° 15' N.; Longitude 81° 27' W.*

Place of observation, magnetic block formerly used.

Date.	Hour.	Needle.	No. Readings.	Dip.
1841, Oct. 27,	10½—11½, A. M.	No. 1,	40	72° 46'.7
"	"	No. 1, poles reversed,	40	55 .0
"	"	Mean of No. 1,	80	50 .9
Nov. 13,	1½—2½, P. M.	No. 1,	40	43 .3
"	"	No. 1, poles reversed,	40	49 .8
"	"	Mean of No. 1,	80	46 .5
Mean of both sets of observations,				72 48 .7